

Large spun formed friction-stir welded tank domes for Liquid Propellant Tanks made from AA2195:

A technology demonstration for the next generation of heavy lift launchers

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Improving structural efficiency while reducing manufacturing costs are key objectives when making future heavy-lift launchers more performing and cost efficient. The main enabling technologies are the application of advanced high performance materials as well as cost effective manufacture processes.

This paper presents the status and main results of a joint industrial research & development effort to demonstrate TRL 6 of a novel manufacturing process for large liquid propellant tanks for launcher applications. Using high strength aluminium-lithium alloy combined with the spin forming manufacturing technique, this development aims at thinner wall thickness and weight savings up to 25% as well as a significant reduction in manufacturing effort.

In this program, the concave spin forming process is used to manufacture tank domes from a single flat plate. Applied to aluminium alloy, this process allows reaching the highest possible material strength status T8, eliminating numerous welding steps which are typically necessary to assemble tank domes from 3D-curved panels.

To minimize raw material costs for large diameter tank domes for launchers, the dome blank has been composed from standard plates welded together prior to spin forming by friction stir welding. After welding, the dome blank is contoured in order to meet the required wall thickness distribution. For achieving a material state of T8, also in the welding seams, the applied spin forming process allows the required cold stretching of the 3D-curved dome, with a subsequent ageing in a furnace.

This combined manufacturing process has been demonstrated up to TRL 6 for tank domes with a 5.4 m diameter. In this paper, the manufacturing process as well as test results are presented. Plans are shown how this process could be applied to future heavy-lift launch vehicles developments, also for larger dome diameters.